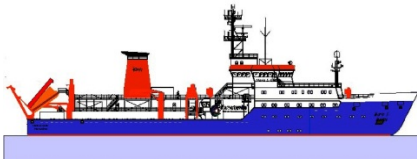
Short Cruise Report



Maria S. MERIAN Cruise No. 17/4
Climate- Biogeochemistry interactions in the in the tropical ocean of the NW-African oxygen minimum zone (SFB754).

Dakar (Senegal) – Las Palmas (Spain) 10. 03. – 11. 04. 2011

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Scientific program

Main research topic of leg MSM 17/4 was the investigation of the oxygen minimum zone (OMZ) in the coastal upwelling areas off Mauretania and Senegal. The research was carried out in the context of the "Sonderforschungsbereich 754" at the University of Kiel, "Climate – Biogeochemistry Interactions in the Tropical Ocean" which is funded by the German Research Council (DFG).

Oceanic oxygen levels are controlled by the interplay of physics and biology. Circulation and mixing transport oxygen into the ocean interior from the near-surface where it is produced by photosynthesis and exchanged with the atmosphere. Oxygen consumption occurs throughout the ocean and is fuelled by organic matter sinking out of surface waters into the depths. Both the supply and consumption of oxygen are sensitive to climate change in ways that are not fully understood.

Major changes to marine sources and sinks of important nutrient elements such as nitrogen, phosphorus and iron occur when oceanic oxygen concentrations decrease below threshold levels. On crossing the threshold, radically different microbial and chemical processes start to operate. Oxygen levels can therefore be viewed as a "switch" or "tipping point" for nutrient cycling.

The Oxygen Minimum Zones (OMZs) of the tropics are the key regions of low oxygen in today's ocean. The effects of oxygen-dependent nutrient cycling in these relatively small regions are carried into the rest of the ocean by the circulation. Hence "small" OMZs can impact nutrient budgets, biological productivity and CO_2-fixation of the global ocean.

Paleo-records from the late Permian and Cretaceous give evidence for periods of dramatically reduced oceanic oxygen levels that had major consequences for marine ecosystems (including mass extinctions). Major low oxygen events, including Cretaceous Ocean Anoxic Events, were associated with warmer climates and higher atmospheric CO_2 levels. Recent modelling results suggest that oceanic oxygen levels will decrease significantly over the next decades in response to high atmospheric CO_2, climate change, and altered ocean circulation.

Hence the future ocean may experience major shifts in nutrient cycling triggered by expansion and intensification of tropical OMZs. There are numerous feedbacks between oxygen levels, nutrient cycling and biological productivity. Positive biogeochemical feedbacks would accelerate climate-initiated oxygen depletion and the spreading of the oxygen minimum zones. Such changes would have profound global consequences for the future ocean, as they have had in the past. However, our existing knowledge is insufficient to understand past interactions or to adequately assess the potential for future change.

The SFB 754 addresses what we consider to be a newly recognised 'tipping point' of the global climate-biogeochemistry system. Specifically, the following key questions are addressed: How does subsurface dissolved oxygen in the tropical ocean respond to changes in ocean circulation and ventilation? What are the sensitivities and feedbacks linking low oxygen levels and key nutrient source and sink mechanisms? What are the magnitudes, timescales and controlling factors of past, present and likely future variations in oceanic oxygen and nutrient levels? The overall goal is to improve understanding of the coupling of tropical climate variability and circulation with the ocean's oxygen and nutrient balance, to quantitatively evaluate the nature of oxygen-sensitive tipping points, as well as to assess consequences for the Ocean's future.

To address these questions we study interactions, tracers, mechanisms and thresholds operating in the present-day tropical ocean as well as examine new records of past changes. The SFB 754 links experimental studies with the development of improved models of redox-sensitive processes involving multiple bio-reactive elements: the biogeochemical models will be integrated with state-of-the-art models of climate change and ocean circulation. Regional foci are on the tropical South East Pacific Ocean and the tropical North East Atlantic Ocean. Addressing the SFB goals requires multi-disciplinary study. The SFB builds upon wide-ranging expertise available in Kiel, including chemical and physical oceanography, sediment biogeochemistry, marine ecology, molecular microbiology, paleoceanography, geology, as well as climate and biogeochemical modelling.

Four SFB754 subprojects participated in cruise MSM 17/4. The scientific program comprised of biological, microbiological, biogeochemical and geochemical investigations of water and sediments as well as paleo-oceanographic investigations. The first part of the expedition led R/V Maria S. MERIAN into Senegalese waters (Fig. 1; 10. 03 -17.03 2011).The second part was exclusively conducted in the Mauretanian EEZ (Fig. 2).

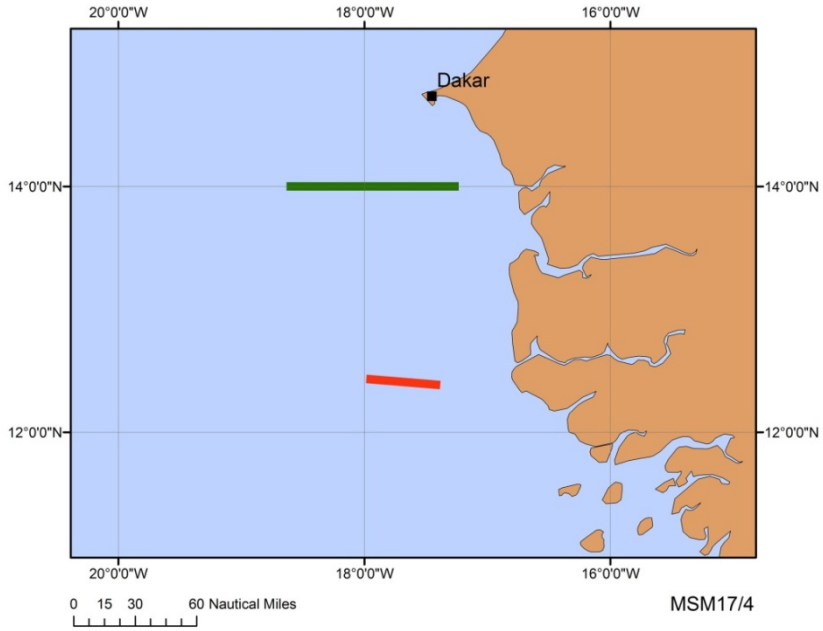

Fig. 1: Investigated depth transects in the Senegalese EEZ.

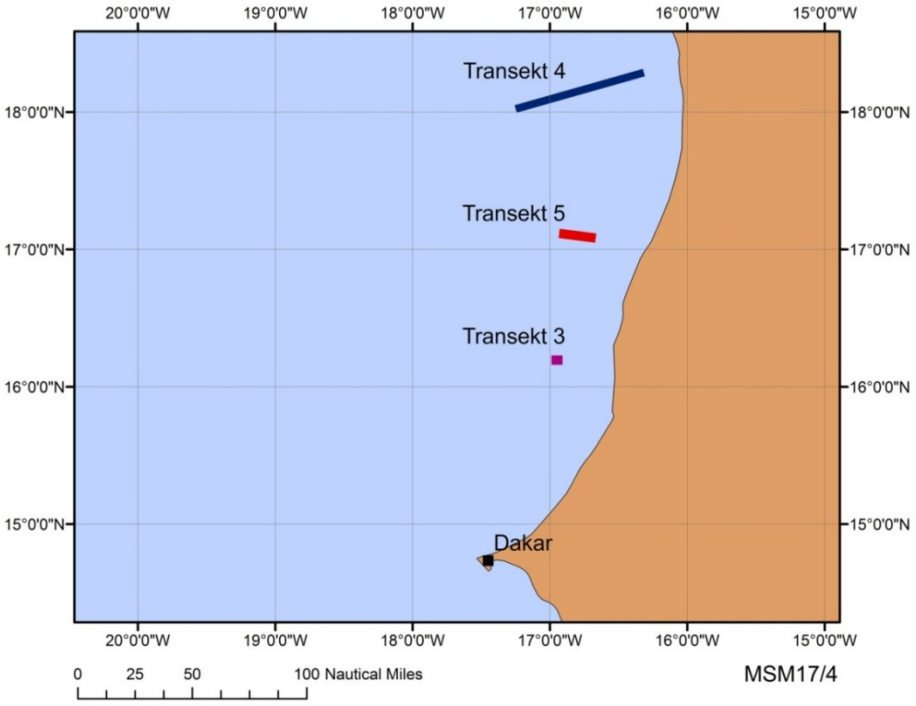

Fig. 2: Investigated depth transects in the Mauretanian EEZ.

Participants

	Name	Function	Institution
1.	Pfannkuche , Olaf	*Chief Scientist*	IFM-GEOMAR
2.	Bertics, Victoria	Microbiology	IFM-GEOMAR
3.	Bleyer, Anke	Geochemistry	IFM-GEOMAR
4.	Bohlen, Lisa	Geochemistry	IFM-GEOMAR
5.	Heller, Maija	Water chemistry	IFM-GEOMAR
6.	Holtappels, Moritz	Nutrient chemistry	MPI-Bremen
7.	Kalvelage, Tim	Nutrient chemistry	MPI-Bremen
8.	Kriwanek, Sonja	Biogeochemistry	IFM-GEOMAR
9.	Lavik, Gaute	Nutrient chemistry	MPI-Bremen
10.	Mallon, Jürgen	Micro-paleontology	IFM-GEOMAR
11.	Martinez, Philipp	Paleoceanography	Univ. Bordeaux
12.	Noffke, Anna	Geochemistry	IFM-GEOMAR
13.	Petersen, Asmus	Gear Technology	IFM-GEOMAR
14.	Rovelli, Lorenzo	Oceonography	IFM-GEOMAR
15.	Schneider, Ralph	Paleoceanography	IFG
16.	Schott, Thorsten	Video Technician	IFM-GEOMAR
17.	Sommer, Stefan	Biogeochemistry	IFM-GEOMAR
18.	Sokoll, Sarah	Molecular Biology	MPI
19.	Treude, Tina	Microbiology	IFM-GEOMAR
20.	Cherednichenko, Sergey	Electronic *Engineer*	IFM-GEOMAR
21.	Wuttig, Katrin	Water chemistry	IFM-GEOMAR
22.	Niang, Ousmane	Observer (11. - 17. 3)	Navy, Senegal
	Bouya M'Bengue	Observer (17. 3. – 11 .4)	IMROP, Mauretania

Narrative of the cruise

Thursday, 10-03-2011
The scientific party which had arrived at midnight on board MARIA S. MERIAN in Dakar harbour started in the morning to strip the containers with the scientific equipment and to install the laboratories. The departure planned for 18:00h had to be cancelled since we had still not received a working permit for Senegalese waters. Therefore we spent the whole day with laboratory and gear preparation and a safety instruction.

Friday, 11-03-2011
In the morning we got the working permission from Senegalese authorities and the Senegalese observer boarded the ship. At 12:48h MERIAN departed from Dakar and headed south to the first working station near the border between Senegal and Guinea-Bissao at 12°23´N.

Saturday, 12-03-2011
We reached our first station on the shelf in 12° 23.40'N/17° 23.70'W at 06:00h and started station work at 75m water depth with a CTD/RO cast (Stat. 320). This action was followed by two CTD/RO casts (Stat. 321-22) at 75m and 103m. A multiple corer (MUC) cast to sample surface sediments at the second CTD/RO position followed (Stat. 323). Afterwards two more CTD/RO cast were driven (Stat. 324-25).

Sunday, 13-03-2011
During the night the ship had moved to a position on the outer slope where we took a MUC sample and made a CTD/RO cast at 2778m (Stat. 326-27).We then moved back in upslope direction taking a MUC sample after a cancelled station (328) at 1734m (Stat. 329). A MUC and CTD/RO cast came next at 781m (Stat. 330-31) and a MUC cast at 391m (Stat. 332). Back on the Shelf we drove a MUC and CTD/RO by 175m (Stat. 333-34) and another MUC by 71m. we then took to a more shallow position around 55m were we employed a water bottle string (GOFLO), the CTD/RO, a bottom water sampler and deployed the benthic boundary layer profiler (BBL-Profiler) Stat. 336-39).

Monday, 14-03-2011
Station work started with a series of three MUC samples (Stat. 340-42).at the 54m- Station. A photographic survey of the area with the Ocean Floor Observation System (OFOS) followed (Stat. 343). With the retrieval of the BBL-PROFILER (Stat 344) we finished station work on the 12° 23'N transect and headed to an area north of the Gambian EEZ at 14°N. We reached the 14° transect at 17:00h and started with a series of three CTD/RO casts each followed by a short OFOS deployment to gain information of the sediment structure between 80m and 325m (Stat. 345-50). A CTD/RO cast and a GOFLO series deployment at 981m finally followed (Stat. 351-352).

Tuesday, 15-03-2011
Our main activities were directed to a station at 80m-84m on the shelf where we deployed in order two MUCs, a CT/RO, a GOFLO series, the BBL-PROFILER, a CTD/RO and the bottom water sampler (Stat, 353-359). An OFOS survey line was driven over the sampling sites (Stat. 360). Next came the deployment of the Biogeochemical Observatory (BIGO) a lander which measures sediment-water interface fluxes of nutrients and gases in benthic chambers (Stat. 361). We changed position for a MUC haul at 457m (Stat. 362). Afterwards we steamed back to the 80m-site where we employed in situ pumps for Seston sampling during the night (Stat.363).

Wednesday, 16-03-2011
We continued our work at the 80m-Station with the retrieval of the BBL-PROFILER (Stat. 364) and two MUC casts (Stat. 365-66). We than moved further inshore for two CTD/RO casts at 60m respectively 46m water

depth (Stat. 367-68). The rest of the day we spent with a down slope transect of MUC sampling at 975m, 1541m, 2556m and 3003m (Stat. Stat 369-72).

Thursday, 17-03-2011

In the morning we retrieved the BIGO Lander (Stat. 373) deployed on 15. 03. Afterwards we finished station work at 14°N and steamed north to Dakar to exchange the Senegalese with the Mauretanian observer. We arrived at noon and lay in the rods. At 14:15 the exchange by a boat was completed and we started our journey to our next station in Mauretanian waters thus finishing our research activities in the EEZ of the Senegal.

Friday, 18-03-2011

We arrived at station in 16° 11.50´N at 06:00h in the morning where we performed a complete water station on the shelf by 91m water depth with CTD-RO casts, and deployments of the bottom water sampler and the BBL-Profiler (Stat. 374-77). Next came three MUC casts at the same station (Stat. 378-80). Afterwards we steamed to the shelf edge where we made a CTD/RO and- a GOFLO-cast and took a MUC sample by 237m water depth (Stat. 381-83). We moved again to the mid slope to take a CTD/RO and MUC cast by 972m. With the retrieval of the BBL-Profiler, deployed in the morning and another CTD/RO cast (Stat. 386-87) we finished station work at 16°N and headed further North.

Saturday, 19-03-2011

We arrived at our next working area at 18°20'N in the morning. Since this area was our main centre of activity during cruise MSM 17/4 we started our work with a detailed pre-site survey of physical, chemical and biogeochemical water properties and a visual inspection of the sediment with the OFOS. We laid out a transect of stations from the middle of the shelf down the continental slope with stations by 50m, 75m, 100m, 150m, 240m, 500m, 760m, 1100m water depth. Each station was sampled with a CTD/RO cast and inspected with OFOS (Stat. 388-403).

Sunday, 20-03-2011

We started our sampling routine near the 100m contour in the early morning employing GOFLO, CTD/RO and MUC (Stat. 404-07). Afterwards we turned to 150m depth and drove a multi-structure sonde (MSS) an extremely high resolving CTD system which is towed oblique. We returned to the morning station and deployed a BIGO lander and took a MUC sample by 98m (Stat. 409-10). Next came a series of CTD/RO casts by 108m, 145 and 189m depth (Stat. 411-13). We finished the day by prolonging our depth transect with a position at 2100m with an OFOS survey and a CTD/RO cast (Stat. 414-15).

Monday, 21-03-2011

The morning started with a survey of the water column at 95-99m water depth with CTD/RO and BWS (Stat. 416-18). Afterwards we deployed the PROFI a lander which carries micro-electrodes for 3D profiles of oxygen in surface sediments, an eddy correlation module and up-and down-looking ADCPs (Stat. 419). The BBL-Profiler was also deployed in 50m distance to the PROFI (Stat. 420). Afterwards we progressed to the shelf edge where we took a MUC sample and deployed our second BIGO lander (Stat. 421-22). A CTD/RO cast by 790m (Stat. 423) and an OFOS survey (Stat. 424) by 243m depth finished the day.

Tuesday, 22-03-2011

The first action of the day was the retrieval of the BIGO lander (Stat. 425) deployed on the 20. 03. Afterwards we took a piston corer sample at 787m which gained a sediment core length of 8m (Stat. 426). We then took back to the shelf and retrieved the BBL-Profiler (Stat. 427). Our activities at this site continued with two CTD/RO and a MUC casts (Stat 428-30). The day ended with Seston sampling with the in situ pump system (Stat. 431).

Wednesday, 23-03-2011

In the course of the night three multi-structure sonde surveys were driven by 98m, 142m and 231m water depth (Stat, 432-34). A MUC sample was taken in the early morning by 242m (Stat. 435) followed by a

CTD/RO cast and an OFOS survey by 410m (Stat. 436-37). In the late morning we retrieved the second BIGO Lander deployed on the 21. 03. The day and early evening were dedicated to CTD/RO cast from the shallowest station at 52m to the upper slope at 770m depth (Stat. 439-45). Afterwards we surveyed a mound structure just beyond the shelf break by 365m with the OFOS (Stat. 446). Here we found reef structures of stone corals, abundant sponges, fishes and crustaceans. A PARASOUND survey to analyse the deep structure of sediments was driven between 1000m and 400m during the whole night (Stat. 447).

Thursday, 24-03-2011

We started in the early morning with three MUC casts by 420m (Stat. 448—50). We then retrieved the PROFI-Lander deployed on the 21. 03., drove another OFOS at the mound site near the shelf break (Stat. 452) and deployed a BIGO lander by 425m (Stat. 453). Two GOFLO deployments and a CTD/RO cast were carried out near the BIGO deployment position (Stat. 454-56). Next came two CTD/RO casts in the mound area slightly east of the previous positions (Stat. 457-458) and three CTD/RO deployments along the 400m contour in 10nm distance of each other (Stat. 459-61).

Friday, 25-03-2011

We started again in the early morning with two MUC casts (Stat 463-63) at the shallowest station of the transect by 52m. Next came two micro-structure sonde tows by 98m and 142m (Stat. 464-65). Afterwards we progressed to the deeper slope and deployed a BIGO lander by 1113m. We then steamed about 20 nautical miles to the north for two Parasound transect on the deeper slope to gain information about sediment structure for better piston coring sites (Stat. 467).

Saturday, 26-03-2011

The Parasound survey continued until early morning. Afterwards we returned to the 400m Station on our 18°N-transect for a CTD/RO and BWS cast (Stat.468-69). Next we deployed the PROFI lander (Stat. 470) and picked up the BIGO lander deployed on the 24. 03. Station work continued with the deployment of the CTD/RO and the BBL-Profiler, the later remained on a wire connected to the ship for 4 hours (Stat. 472-73). We then changed position to the adjacent mound structures for an OFOS survey (Stat. 474). The night was dedicated again to Parasound surveys of the deeper slope 30nm north of the 18°-transect (Stat. 475).

Sunday, 27-03-2011

In the mid-morning we returned to the deployment site of the BIGO lander by 1113m and retrieved the instrument (Stat, 476). We then moved upslope to 400m for another water column survey where we employed the bottom water sampler, the BBL-Profiler, the CTD/RO and finished with a four hours of in situ pumping (Stat. 477-81).

Monday 28-03-2011

During the night we move to 18° 26´N to an area with a sediment composition favourable for piston corer sampling (Stat. 482). During the launching procedure of the piston corer while hanging above the water the release mechanism was triggered by accidental contact with core catcher and the instrument fell through breaking the ships 18mm wire. In consequence we lost the instrument and thereby our deep sediment coring capability. Afterwards we returned to the 18°-transect and took two MUC samples by 1108m (Stat, 83-84). We then move the transect upslope to the 50m shelf station to deploy a BIGO lander (Stat. 485). Next came a series of CTD/RO casts by 950m, 1110m, 1496m and 1836m which enlarged our transect line down slope (Stat. 486-89).

Tuesday, 29-03-2011

The day started with the retrieval of the PROFI lander deployed on the 26. 03. by 418m (Stat. 490). We then moved further down slope for two GOFLO casts and a multi-structure sonde cast at around 700m (Stat. 491-93). Next came the deployment of a BIGO lander, a CTD/RO and a MUC cast by 787m (Stat. 494-96). During the night until next morning we started with a multi-beam survey with the EM-1002 to produce

a bathymetric map of the upper slope and shelf between 50m and 500m water depth. Three survey lines were driven in the course of the Station (497).

Wednesday, 30-03-2011

Late morning activity started with the retrieval of the BIGO lander deployed on the 28. 03 (Stat. 498). Afterwards we turned to MUC sampling along the transect line by 45m, 175m, 500m, 1496m and 1843m (Stat. 499-503). Having reached the deepest point of this line we made a CTD/RO cast (Stat. 504) turned back to 787m to make an overnight measurement with the BBL-Profiler attached to the ship´s wire (Stat. 505).

Thursday, 31-03-2011

We started activities in the morning with a MUC cast near the at the BBL-Profiler site from the previous night (Stat. 506) We than moved further upslope where we drove a multi- structure sonde line and made two OFOS surveys around 300-350m (Stat. 507-09). Afterwards we returned to the 787m site to deploy the PROFI lander (Stat. 510). The night was spent again with a multi-beam survey with the EM-1002 of the 50m to 500m section of the transect (Stat. 511).

Friday, 01-04-2011

In the morning we continued our work at the 780m site with a MUC cast and the retrieval of the BIGO lander deployed on 29. 03 (Stat. 512-13). We changed then for water column sampling employing GOFLO (2 casts), CTD/RO (3casts), bottom water sampler and deployed the BBL-Profiler on the ship´s wire (Stat. 514-19). During the night we steamed to a position 110nm west of the 780m site to reach the 3000m depth contour.

Saturday, 02-04-2011

We reached our deepest station at 18° 32'W and drove a CTD/RO, two MUCs and made an OFOS survey by 3010m (Stat. 520-23). During the night we steamed back to the 780m site.

Sunday, 03-04-2011

We started work in the morning with the retrieval of the PPROFI lander deployed on 01. 04. (Stat. 534). Afterwards we turned back to deeper water around 1110m where we made 2 GOFLO and a CTD/RO cast (Stat 525-27). Then we moved to the shelf were we took two MUC samples by 76m (Stat.528-29). In the evening we returned to 780m to deploy a BIGO lander (Stat. 530). During the evening and early night we completed the multi-beam survey with the EM-1002 filling gaps of the previous surveys (Stat. 531).

Monday, 04-04-2011

During the late night and early morning we employed the in situ pumps by 400m (Stat. 532). Work continued at this site with a BBL-Profiler cast, a bottom water sampler and a CTD/RO cast (Stat. 533-35). We than moved to the shelf for a MUC cast by 174m (Stat. 536) and a deployment of the PROFI lander by 53m (Stat. 537). We returned again to the 174m site for an OFOS survey and a deployment of the BIGO lander (Stat. 538-39). During the evening and night we started with a multi-beam survey with the EM-120 to produce a bathymetric map of the deeper part of the 18°-transect between 500m and 1500m.

Tuesday, 05-04-2011

Station work in the morning focussed to the shelf break where we made two GOFLO and one CTD/RO cast (Stat. 541-43). We went to deeper water and retrieved the BIGO lander at the 780m site deployed two days before. We then steamed to the south to open a new survey line at 17°N, where we deployed the BBL-Profiler by 110m and made a bottom water sampler and made CTD/RO cast at the same position (Stat. 545-47). During the rest of the day three more CTD/RO casts followed by 75m 318m and 1055m (Stat. 548-50).

Wednesday, 06-04-2011

In the early morning we retrieved the BBL-Profiler (Stat. 551) deployed the day before. Afterwards we steamed back to the 18°-transect line and retrieved the BIGO Lander (Stat. 552) deployed on the 05. 04.

We continued work in the shallow shelf section (52m - 55m) by towing the multi-structure sonde, making a MUC cast and deploying the BBL-Profiler and recovering the PROFI lander (Stat. 553-556). We then turned to CTD/RO casting and employed the bottom water sampler at the same location (Stat. 557-58). During the night we drove some multi-beam survey lines with the EM-120 to map the deep part of our transect line between 500m and 1200m (Stat. 559).

Thursday, 07-04-2011

In the morning we returned to 50m location. En route we took a MUC by 98m (Stat. 560) followed by a CTD/RO cast and the retrieval of the BBL-Profiler (Stat. 561-62) at the shallow site. We then turned back to the upper slope to work in the location around the 250m depth contour. After the deployment of the PROFI Lander (Stat. 563) we started a 24h-survey of the water column with repeated CTD/RO cast and intermittent tows of the multi- structure sonde and a another deployment of the BBL-Profiler (Stat. 564-572).

Friday, 08-04-2011

The combined CTD/RO/multi-structure sonde survey around the 250m contour was continued during the night and day into the afternoon with one additional MUC cast by 255m (Stat. 573-589). With the retrieval of the BBL-Profiler and the PROFI Lander (Stat. 590-91) we finished our station work on the 18°-transect and started to the north towards Las Palmas.

Saturday, 09-04-2011

During the morning we interrupted our passage to Las Palmas to take a set of samples for the Mauretanian IMROP Institute at 17° 45`N. We took water samples with GOFLO and the CTD/RO and cored sediments with the MUC by 592m (Stat. 592-94). With this activity we finally finished sampling and surveying activities in Mauretanian waters and steamed further north.

Sunday, 10-04-2011

We continued our journey to Las Palmas (Canary Islands).

Monday, 11-04-2011

We arrived at Las Palmas in the early afternoon and started immediately after docking with the unloading of the containers with the scientific equipment. One 14''-container carrying the landers had to be loaded on shore. At 18:00h the last members of the scientific party left the ship thus finishing Maria S. MERIAN cruise 17 leg 4.

Employed gear with abbreviations

- Water column analysis and sampling**:**

CTD/RO CTD/Rosette water sampler
GOFLO Water bottle series
MSS Micro-structure sonde (CTD)
BWS Bottom water sampler
BBLP Benthic boundary layer profiler
ISP in situ pumps

- Sediment sampling and measurements:

BIGO-1 Biogeochemical observatory (Lander) No. 1
BIGO-2 Biogeochemical observatory (Lander) No. 2
PROFI Micro-electrode sediment profiler (Lander)
MUC TV- multiple corer
KOL Piston corer

- Sea floor observation and photography:

OFOS Ocean floor observation system

List of sampling stations

Coordinates 1: Gear at bottom /sampling position

Coordinates 2: Gear off bottom (e.g. after an OFOS line)

Depl.: Deployment on the seafloor

Retr.: Retrieval

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
320	CTD/RO	1	12.03.	06:00	12°23,400	17°23,700	73				
321	CTD/RO	2	12.03.	07:55	12°26,288	17°17,088	75				
322	CTD/RO	3	12.03.	09:55	12°21,239	17°25,032	103				
323	MUC	1	12.03.	16:25	12°23,390	17°23,700	73				
324	CTD/RO	4	12.03.	18:03	12°32,994	17°33,731	104				
325	CTD/RO	5	12.03.	19:32	12°43´884	17°37,948	74				
326	MUC	2	13.03.	06:55	12°26,300	17°58,800	2778				
327	CTD/RO	6	13.03.	07:55	12°26,301	17°58,802	2774				
328	cancelled										
329	MUC	3	13.03.	13:12	12°27,360	17°45,120	1734				
330	MUC	4	13.03.	15:09	12°28,270	17°35,320	781				
331	CTD/RO	7	13.03.	15:30	12°28,278	17°35,320	780				
332	MUC	5	13.03.	16:44	12°28,440	17°34,010	391				
333	MUC	6	13.03.	17:16	12°28,540	17°32,800	176				
334	CTD/RO	8	13.03.	17:40	12°28,540	17°32,819	175				
335	MUC	7	13.03.	19:25	12°23,350	17°23,700	71				
336	GOFLO	1	13.03.	22:34	12°49,990	17°33,850	53				
337	CTD/RO	9	13.03.	22:35	12°49,997	17°33,848	54				
338	BWS	1	13.03.	23:00	12°49,997	17°33,848	54				
339	BBL-P Depl.	1	13.03.	23:45	12°49,989	17°33,869	54				
340	MUC	8	14.03.	07:21	12°50,000	17°33,840	54				
341	MUC	9	14.03.	08:22	12°50,009	17°33,841	54				
342	MUC	10	14.03.	08:57	12°50,020	17°33,840	54				
343	OFOS	1	14.03.	10:02	12°50,293	17°33,911	54	12°49,872	17°34,016	54	11:05
344	BBL-P Retr.	1	14.03.	11:50							
345	CTD/RO	10	14.03.	17:09	13°47,975	17°24,007	93				
346	OFOS	2	14.03.	17:34	13°47,980	17°24,005	92	13°47,943	17°24,021	92	17:40
347	CTD/RO	11	14.03.	19:00	13°59.966	17°24,010	80				
348	OFOS	3	14.03.	19:24	13°59,966	17°24,010	80	13°59,960	17°24,030	80	19:40
349	CTD/RO	12	14.03.	20:21	14°00,001	17°30,001	326				
350	OFOS	4	14.03.	21:08	14°00,001	17°30,001	326	13°59,960	17°30,110	341	21:23
351	CTD/RO	13	14.03.	22:25	13°59,925	17°37,473	981				
352	GOFLO	2	15.03.	00:03	13°59,927	17°37,473	981				
353	MUC	11	15.03.	06:49	14°00,000	17°24,000	80				
354	MUC	12	15.03.	07:19	14°00,001	17°24,000	80				

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
355	CTD/RO	14	15.03.	08:05	14°00,203	17°24,005	81				
356	GOFLO	3	15.03.	09:03	14°00,187	17°24,004	81				
357	BBL-P Depl.	2	15.03.	09:20	14°00,008	17°24,060	81				
358	CTD/RO	15	15.03.	10:10	14°00,124	17°24,076	81				
359	BWS	2	15.03.	11:05	14°00,129	17°24,073	81				
360	OFOS	5	15.03.	13:27	14°59,795	17°24,253	81	14°00,240	17°24,321	83	14:24
361	BIGO-I Depl.	1	15.03.	14:16	14°00,994	17°25,105	84				
362	MUC	13	15.03.	20:02	13°59,942	17°31,025	457				
363	ISP	1	15.03.	21:30	14°00,000	17°24,000	81				
364	BBL-P Retr.	2	16.03.	06:00							
365	MUC	14	16.03.	07:17	14°,00,000	17°24,002	81				
366	MUC	15	16.03.	07:41	13°59,999	17°24,001	81				
367	CTD/RO	16	16.03.	08:30	13°59,975	17°19,002	61				
368	CTD/RO	17	16.03.	09:31	13°59,999	17°14,002	46				
369	MUC	16	16.03.	12:50	14°15,470	17°40,010	975				
370	MUC	17	16.03.	15:19	14°17,800	17°49,010	1541				
371	MUC	18	16.03.	18:33	14°19,999	18°02,000	2556				
372	MUC	19	16.03.	23:38	14°19,990	18°32,210	3003				
373	BIGO-I Retr.	1	17.03.	08:05							

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
374	CTD/RO	18	18.03.	06:00	16°11,500	16°45,004	91				
375	BBL-P Depl.	3	18.03.	07:00	16°11,445	16°45,027	91				
376	CTD/RO	19	18.03.	08:00	16°11,445	16°45,027	91				
377	BWS	3	18.03.	09:00	16°11,445	16°45,026	91				
378	MUC	20	18.03.	09:51	16°11,445	16°45,026	91				
379	MUC	21	18.03.	10:10	16°11,446	16°45,027	91				
380	MUC	22	18.03.	10:37	16°11,449	16°45,027	91				
381	CTD/RO	20	18.03.	11:25	16°11,500	16°52,005	237				
382	GOFLO	4	18.03.	12:42	16°11,500	16°52,004	236				
383	MUC	23	18.03.	13:13	16°11,510	16°52,004	237				
384	CTD/RO	21	18.03.	14:05	16°11,500	16°59,002	971				
385	MUC	24	18.03.	15:38	16°11,500	16°59,010	972				
386	BBL-P Retr.	3	18.03.	19:00							
387	CTD/RO	22	18.03.	19:30	16°11,452	16°45,076	91				
388	CTD/RO	23	19.03.	07:00	18°17,300	16°19,004	52				
389	OFOS	6	19.03.	07:24	18°17,300	16°19,004	51	18°17,265	16°19,042	07:32	51
390	CTD/RO	24	19.03.	08:16	18°16.273	16°24,002	76				
391	OFOS	7	19.03.	08:42	18°16,273	16°24,002	76	18°16,254	16°24,030	08:48	76
392	CTD/RO	25	19.03.	09:24	18°15,282	16°24,008	96				
393	OFOS	8	19.03.	09:52	18°15,282	16°24,008	96	18°15,263	16°27,040	10:00	96
394	CTD/RO	26	19.03.	10:38	18°14,276	16°30,015	143				
395	OFOS	9	19.03.	11:04	18°14,276	16°30,015	143	18°14,243	16°30,060	11:15	144
396	CTD/RO	27	19.03.	13:03	18°13,099	16°33,300	239				
397	OFOS	10	19.03.	13:40	18°13,101	16°33,299	239	18°13,151	16°33,319	13:46	239

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
398	CTD/RO	28	19.03.	14:26	18°12,365	16°36,580	507				
399	OFOS	11	19.03.	15:32	18°12,365	16°36,582	507	18°12,405	16°36,601	15:38	509
400	CTD/RO	29	19.03.	16:20	18°11,339	16°39,148	767				
401	OFOS	12	19.03.	17:35	18°11,338	16°39,147	767	18°11,299	16°39,165	17:42	775
402	CTD/RO	30	19.03.	18.55	18°09,999	16°44,994	1108				
403	OFOS	13	19.03.	20:25	18°10,000	16°44,996	1108	18°09,945	16°45,017	20:35	1112
404	GOFLO	5	20.03.	06:24	18°15,299	16°27,001	95				
405	CTD/RO	31	20.03.	07:18	18°15,300	16°26,999	95				
406	MUC	25	20.03.	08:28	18°15,229	16°27,000	98				
407	MUC	26	20.03.	08:59	18°15,301	16°27,000	98				
408	MSS	1	20.03.	10:30	18°13,35	16°30,120	147				
409	BIGO-I Depl.	2	20.03.	14:39	18°15,200	16°27,000	98				
410	MUC	27	20.03.	15:28	18°15,324	16°27,010	96				
411	CTD/RO	32	20.03.	16:02	18^14,970	16°28,283	108				
412	CTD/RO	33	20.03.	16:50	18°14,300	16°30,001	145				
413	CTD/RO	34	20.03.	17:55	18°14,449	16°31,299	189				
414	OFOS	14	20.03.	22:57	18°01,420	17°14,980	2159	18°01,120	17°14,990	23:30	2149
415	CTD/RO	35	21.03.	00:32	18°01,404	17°14,999	2152				
416	CTD/RO	36	21.03.	07:00	18°15,319	16°27,023	99				
417	BWS	4	21.03.	08:15	18°15,319	16°27,022	93				
418	CTD/RO	37	21.03.	09:23	18°15,319	16°27,023	94				
419	PROFI Depl.	1	21.03.	10:52	18°15,319	16°27,023	98				
420	BBL-P Depl.	4	21.03.	11:10	18°15,310	16°27,020	95				
421	MUC	28	21.03.	12:39	18°13,049	16°33,303	241				
422	BIGO-II Depl.	1	21.03.	15:42	18°13,100	16°33,303	241				
423	CTD/RO	38	21.03.	16:40	18°11,261	16°39,303	790				
424	OFOS	15	21.03.	18:47	18°13,029	16°33,291	243	18°12,802	16°33,301	19.21	257
425	BIGO-I Retr.	2	22.04.	08:00							
426	KOL	1	22.04.	11:10	18°11,299	16°39,306	787				
427	BBL-P Retr.	4	22.04.	14:30							
428	CTD/RO	39	22.03.	14:50	18°15,304	16°27,025	96				
429	MUC	29	22.03.	18:12	18°15,310	16°27,024	96				
430	CTD/RO	40	22.03.	18:25	18°15,310	16°27,026	96				
431	ISP	2	22.03.	20:00	18°15,209	16°27,025	98				
432	MSS	2	23.03.	00:38	18°15,010	16°27,090	98				
433	MSS	3	23.03.	03:20	18°14,010	16°27,12	142				
434	MSS	4	23.03.	05:05	18°12,870	16°33,030	231				
435	MUC	30	23.03.	06:22	18°13,096	16°33,331	242				
436	CTD/RO	41	23.03.	07:00	18°12,609	16°35,515	410				
437	OFOS	16	23.03.	08:20	18°12,609	16°35,516	410	18°12,545	16°35,650	08:50	421
438	BIGO-II Retr.	1	23.03.	10:00							
439	CTD/RO	42	23.03.	12:56	18°17,300	16°19,015	52				
440	CTD/RO	43	23.03.	13:45	18°16,273	16°24,007	76				
441	CTD/RO	44	23.03.	14:35	18°15,286	16°27,013	96				
442	CTD/RO	45	23.03.	15:20	18°14,226	16°30,000	145				
443	CTD/RO	46	23.03.	16:35	18°13,031	16°33,319	244				

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
444	CTD/RO	47	23.03.	17:50	18°12,364	16°36,584	510				
445	CTD/RO	48	23.03.	19:00	18°11,339	16°39,153	770				
446	OFOS	17	23.03.	20:51	18°11,890	16°34,210	365	18°11,678	16°34,439	21:27	434
447	PARASOUND	1	23.03.	21:28	18°11,678	16°34,439	436				
448	MUC	31	24.03.	06:17	18°12,550	16°35,599	417				
449	MUC	32	24.03.	06:57	18°12,554	16°35,599	423				
450	MUC	33	24.03.	07:32	18°12,553	16°35,601	416				
451	PROFI Retr.	1	24.03.	08:45							
452	OFOS	18	24.03.	10:32	18°12,304	16°33,537	340	18°12,184	16°33,898	11:25	347
453	BIGO-I Depl.	3	24.03.	15:46	18°12,540	16°35,647	425				
454	GOFLO	6	24.03.	16:35	18°12,454	16°35,598	417				
455	CTD/RO	49	24.03.	17:13	18°12,453	16°35,598	418				
456	GOFLO	7	24.03.	18:20	18°12,453	16°35,598	418				
457	CTD/RO	50	24.03.	19:04	18°12,450	16°24,998	373				
458	CTD/RO	51	24.03.	20:00	18°11,890	16°34,219	362				
459	CTD/RO	52	24.03.	22:30	18°23,230	16°44,025	447				
460	CTD/RO	53	25.03.	00:30	18°34,195	16°42,006	429				
461	CTD/RO	54	25.03.	02:25	18°42,700	16°46,896	494				
462	MUC	34	25.03.	06:28	18°17,299	16°19,011	53				
463	MUC	35	25.03.	06:49	18°17,299	16°19,006	52				
464	MSS	5	25.03.	08:42	18°14,340	16°26,000	98				
465	MSS	6	25.03.	12:00	18°13,520	16°30,000	142				
466	BIGO-II Depl.	2	25.03.	16:04	18°09,995	16°45,003	1113				
467	PARASOUND	2	25.03.	20:20	18°30,000	17°10,000	2105				
468	CTD/RO	55	26.03.	06:10	18°12,421	16°35,551	415				
469	BWS	5	26.03.	07:30	18°12,422	16°35,551	414				
470	PROFI	2	26.03.	09:11	18°12,452	16°35,641	418				
471	BIGO-I Retr.	3	26.03.	09:00							
472	BBL-P	5	26.03.	11:10	18°12,422	16°35,500	414				
473	CTD/RO	56	26.03.	16:27	18°12,419	16°35,559	415				
474	OFOS	19	26.03.	17:50	18°12,273	16°33,418	327	18°12,325	16°33,991	18:55	322
475	PARASOUND	3	26.03.	23:55	18°49,780	17°12,540	1856				
476	BIGO-II Retr.	2	27.03.	10:00							
477	CTD/RO	57	27.03.	12:45	18°12,401	16°35,500	409				
478	BWS	6	27.03.	16:10	18°12,400	16°35,500	409				
479	BBL-P	6	27.03.	17:32	18°12,401	16°35,499	409				
480	CTD/RO	58	27.03.	22:00	18°12,400	16°35,499	409				
481	ISP	3	28.03.	00:00	18°12,400	16°35,499	409				
482	KOL	2	28.03.	08:20	18°26,250	16°53,950	1304	no sample			
483	MUC	36	28.03.	11:10	18°09,999	16°45,000	1108				
484	MUC	37	28.03.	12:29	18°10,003	16°45,011	1109				
485	BIGO-I Depl.	4	28.03.	17:00	18°17,295	16°19,008	53				
486	CTD/RO	59	28.03.	19:10	18°11,000	16°41,300	950				
487	CTD/RO	60	28.03.	21:00	18°10,000	16°45,002	1110				
488	CTD/RO	61	28.03.	23:10	18°08,002	16°52,001	1496				

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
489	CTD/RO	62	29.03.	02:10	18°05,000	17°02,002	1836				
490	PROFI Retr.	2	29.03.	06:35							
491	GOFLO	8	29.03.	08:34	18°11,302	16°39,302	786				
492	MSS	7	29.03.	10:20	18°11,600	16°35,670	523				
493	GOFLO	9	29.03.	15:00	18°11,301	16°39,302	786				
494	BIGO-II Depl.	3	29.03.	17:11	18°11,297	16°39,309	787				
495	CTD/RO	63	29.03.	17:50	18°11,312	16°39,321	787				
496	MUC	38	29.03.	19:43	18°11,312	16°39,322	787				
497	EM-1002 Start	1	29.03.	20:15	18°12,450	16°36,000	550				
498	BIGO-I Retr.	4	30.03.	10:15							
499	MUC	39	30.03.	10:37	18°17,296	16°19,007	45				
500	MUC	40	30.03.	12:18	18°14,298	16°31,009	175				
501	MUC	41	30.03.	14:17	18°11,464	16°35,721	500				
502	MUC	42	30.03.	17:05	18°07,998	16°52,007	1496				
503	MUC	43	30.03.	19:39	18°04,996	17°02,007	1843				
504	CTD/RO	64	30.03.	20:30	18°04,995	17°02,009	1849				
505	BBL-P	7	31.03.	00:32	18°11,319	16°39321	787				
506	MUC	44	31.03.	07:19	18°11.311	16°39,320	786				
507	MSS	8	31.03.	09:30	18°12,160	16°39,230	309				
508	OFOS	20	31.03.	14:03	18°11,890	16°34,210	366	18°11,732	16°34,381	14:32	393
509	OFOS	21	31.03.	15:14	18°11,920	16°34,152	364	18°11,713	16°34,355	15:49	401
510	PROFI Depl.	3	31.03.	17:25	18°11,308	16°39,320	787				
511	EM-1002 Start	2	31.03.	18.44	18°11,540	16°37,220	679				
512	MUC	45	01.04.	07:31	18°11,297	16°39,287	786				
513	BIGO-II Retr.	3	01.04.	08:16							
514	GOFLO	10	01.04.	09:26	18°11,301	16°39,299	786				
515	CTD/RO	65	01.04.	10:10	18°11,302	16°39,300	787				
516	BWS	7	01.04.	12:30	18°11,302	16°39,299	786				
517	GOFLO	11	01.04.	16:29	18°11,252	16°39,274	791				
518	BBL-P	8	01.04.	17:20	18°11,296	16°39,306	787				
519	CTD/RO	66	01.04.	23:25	18°11,296	16°39,305	787				
520	CTD/RO	67	02.04.	11:25	18°13,002	18°32,917	3010				
521	MUC	46	02.04.	15:09	18°13,012	18°32,005	3020				
522	MUC	47	02.04.	17:13	18°13,009	18°32,002	3024				
523	OFOS	22	02.04.	19:30	18°13,009	18°32,101	2980	18°12,967	18°32,753	20:18	2910
524	PROFI Retr.	3	03.04.	08:13							
525	GOFLO	12	03.04.	09:57	18°09,999	16°45,009	1111				
526	CTD/RO	68	03.04.	10:00	18°09,999	16°45,007	1109				
527	GOFLO	13	03.04.	13:26	18°10,056	16°45,022	1115				
528	MUC	48	03.04.	15:45	18°16,266	16°24,006	76				
529	MUC	49	03.04.	16:04	18°16,268	16°24,007	77				
530	BIGO-I Depl.	5	03.04.	18:26	18°11,286	16°39,315	789				
531	EM-1002 Start	3	03.04.	20:13	18°14,080	16°34,670	341				

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
532	ISP	4	04.04.	02:00	18°12,398	16°35,507	410				
533	BBL-P	9	04.04.	07:00	18°12,98	16°35,507	410				
534	BWS	8	04.04.	10:57	18°12,407	16°35,506	410				
535	CTD/RO	69	04.04.	11:50	18°12,406	16°35,507	410				
536	MUC	50	04.04.	13:32	18°14,298	16°31,008	174				
537	PROFI Depl.	4	04.04.	15:07	18°17,236	16°19,006	53				
538	OFOS	23	04.04.	16:38	18°14,294	16°31,006	173	18°14,061	16°31,095	17:08	174
539	BIGO-II Depl.	4	04.04.	18:38	18°14,297	16°31,006	174				
540	EM-120 Start	1	04.04.	19:36	18°12,370	16°36,280	474				
541	GOFLO	14	05.04.	06:10	18°13,099	16°33,309	240				
542	CTD/RO	70	05.04.	07:00	18°13,098	16°33,309	240				
543	GOFLO	15	05.04.	08:32	18°13,040	16°33,346	245				
544	BIGO-I Retr.	5	05.04.	09:20							
545	BBL-10 Depl.	10	05.04.	16:10	17°04,998	16°40,010	110				
546	CTD/RO	71	05.04.	16:25	17°05,014	16°40,080	110				
547	BWS	9	05.04.	17:00	17°05,014	16°40,080	110				
548	CTD/RO	72	05.04.	19:20	17°05,023	16°29,610	75				
549	CTD/RO	73	05.04.	00:00	17°07,998	16°47,008	318				
550	CTD/RO	74	05.04.	23:25	17°07.995	16°56,006	1055				
551	BBL-P Retr.	10	06.04.	05:00							
552	BIGO-II Retr.	5	06.04.	12:07							
553	MSS	8	06.04.	13:58	18°16,900	16°18,890	53				
554	MUC	51	06.04.	16:17	18°17,351	16°19,152	53				
555	BBL-P Depl.	11	06.04.	16:30	18°17,265	16°19,144	52				
556	PROFI Retr.	4	06.04.	18:02							
557	CTD/RO	75	06.04.	18.30	18°17,256	16°19,116	52				
558	BWS	10	06.04.	19:00	18°17,257	16°19,116	52				
559	EM-120 Start	2	06.04.	21:04	18°12,650	16°36,010	454				
560	MUC	52	07.04.	08:07	18°15,305	16°27,032	98				
561	BBL-P Retr.	11	07.04.	09:00							
562	CTD/RO	76	07.04.	09:50	18°17,341	16°19,158	54				
563	PROFI Depl.	5	07.04.	12:47	18°13,007	16°33,390	243				
564	CTD/RO	77	07.04.	13:50	18°12,900	16°33,310	253				
565	MSS	9	07.04.	14:55	18°12,150	16°33,300	253				
566	BBL-P Depl.	12	07.04.	17:25	18°13,104	16°33,387	245				
567	CTD/RO	78	07.04.	17:53	18°12,895	16°33,311	253				
568	MSS	10	07.04.	18:21	18°12,920	16°33,300	252				
569	CTD/RO	79	07.04.	20:45	18°12,893	16°33,305	250				
570	CTD/RO	80	07.04.	20:00	18°12,899	16°33,305	252				
571	CTD/RO	81	07.04.	21:30	18°12,899	16°33,305	252				
572	MSS	11	07.04.	22:00	18°12,899	16°33,305	252				
573	CTD/RO	82	08.04.	00:17	18°12,899	16°33,306	263				
574	CTD/RO	83	08.04.	00:55	18°12,900	16°33,305	253				
575	CTD/RO	84	08.04.	00:00	18°12,899	16°33,305	254				
576	MSS	12	08.04.	02:17	18°12,898	16°33,280	254				

Station	Gear	No.	Date	Time	Coordinates 1		Depth	Coordinates 2		Depth	Time
MSM-17			2011	(UTC)	Lat. °N	Long. °W	(m)	Lat. °N	Long. °W	(m)	(UTC)
577	CTD/RO	85	08.04.	04:15	18°12,899	16°33,305	253				
578	CTD/RO	86	08.04.	05:00	18°12,899	16°33,305	252				
579	CTD/RO	87	08.04.	05:30	18°12,899	16°33,305	252				
580	MSS	13	08.04.	06:10	18°12,899	16°33,305	252				
581	CTD/RO	88	08.04.	08:00	18°12,899	16°33,305	252				
582	CTD/RO	89	08.04.	08:45	18°12,900	16°33,305	252				
583	CTD/RO	90	08.04.	09:20	18°12,899	16°33,306	252				
584	MUC	53	08.04.	10:23	18°12,898	16°33,304	255				
585	MSS	14	08.04.	10:43	18°12,910	16°33,300	253				
586	CTD/RO	91	08.04.	12:40	18°12,899	16°33,304	252				
587	CTD/RO	92	08.04.	13:20	18°12,899	16°33,304	252				
588	CTD/RO	93	08.04.	14:00	18°12,899	16°33,304	252				
589	MSS	15	08.04.	14:41	18°12,899	16°33,304	252				
590	BBL-P Retr.	12	08.04.	20:00							
591	PROFI Retr.	5	08.04.	18:21							
592	GOFLO	16	09.04.	09:25	20°20,000	17°45,011	592				
593	CTD/RO	94	09.04.	09:50	20°20,000	17°45,011	592				
594	MUC	54	09.04.	10:48	20°19,998	17°45,010	593				